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Instrumentation and Robotic Image Processing Using Top-Down Model Control

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A top-down image processing scheme is described. A three-dimensional model of a robotic working environment, with robot manipulators, workpieces, cameras, and on-the-scene visual enhancements is employed to control and direct the image processing, so that rapid, robust algorithms act in an efficient manner to continually update the model. Only the model parameters are communicated, so that savings in bandwidth are achieved. This image compression by modeling is especially important for control of space telerobotics.

The background for this scheme lies in an hypothesis of human vision put forward by the senior author and colleagues almost 20 years ago—the Scanpath Theory. Evidence was obtained that repetitive sequences of saccadic eye movements, the scanpath, acted as the checking phase of visual pattern recognition. Further evidence was obtained that the scanpaths were apparently generated by a cognitive model and not directly by the visual image. This top-down theory of human vision was generalized in some sense to the 'frame' in artificial intelligence.

Another source of our concept arose from bioengineering instrumentation for measuring the pupil and eye movements with infrared video cameras and special-purpose hardware. Since the image available to the instrument camera was well-defined, a model of the view could be used to direct the image processing algorithms to particular regions of interest and to particular parameters such as the diameter of the pupil or the centroid of the corneal reflection. Thus, robust, rapid image processing could be obtained under control by the known top-down picture.